Electric Power Transmission



Objectives

- Overview of the transmission system
- Parts of the transmission system
 - High capacity customers
 - Switching stations
 - Substations
 - Apparatus
- Overview of transformers
- Transmission lines
- Transmission specs

Transmission System

The transmission system is normally connected to a **subtransmission** system, which in turn is connected to a distribution system.

Early transmission systems evolved into compatible, interconnected grids.



Transmission serves two main purposes:

1. To transfer electricity from generation plants

2. To interconnect the various electric utility systems



Parts of the Transmission System

- Generation sources
- Switching stations
- Power grids
- Very high capacity customers
- Substation and subtransmission systems



High capacity customers might include:

- Manufacturing plants
- Research facilities
- Industrial operations
- Nuclear plants
- Educational institutions
- Hospitals



Switching Stations

Power passes from the generation plant into the transmission system through a switching station (or switchyard).

This is the area of the generation plant where power is transformed and routed.

Switching stations also monitor line currents, voltages, and power flow.



Substations

Substations are located along the transmission route ans contain equipment that transforms and routes power.

This is where power is stepped down to lower voltages or stepped up to higher voltages with large transformers.



Transmission System Apparatus

• A **bus** is a specially designed conductor that has very low resistance.





Transformer circuit
breakers protect
equipment from being
overloaded.

Transformer Basics

- Transformers consist of two windings coiled around an iron core and placed in a covered tank.
- The primary winding is connected to the source voltage.
- The secondary winding is connected to the load.



More on transformers...

As alternating current flows in the primary winding, a magnetic field develops in the iron core. When the current reverses direction, the magnetic field also changes direction. This action induces a **different voltage** in the secondary winding. If the secondary circuit is closed. current will flow.

Even more on transformers...

- If a transformer has the same number of turns in the primary and the secondary windings, the voltage will be the same on both sides of the transformer.
- Step-up = primary voltage < secondary voltage

 Step-down = primary voltage > secondary voltage

Inside of a transformer...



Transmission Lines

 Overhead lines are usually composed of strands of aluminum alloy and steel.

 Transmission towers are equipped with ground wires and lightning arresters to prevent or reduce damage from lightning strikes.





More on transmission lines...

While overhead lines are insulated and cooled by air, **underground** transmission lines are usually insulated by a nonconductive covering and cooled by oil cooling systems.



Transmission specs

- The transmission system operates at high voltages that range from 138,000 to more than 1,000,000 volts. (138kV to 1MV)
- Limitations on the load that can be supported by transmission lines include:
 - Thermal limits
 - Voltage drops
 - Conductor losses
 - Line losses
 - Corona losses



High voltage

Other info...

- Opposition to AC flow due to the buildup of electric or magnetic fields is called **reactance**.
- An oscilloscope is a type of instrument used to measure and display waveforms created by electric current.



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